PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-271664

(43)Date of publication of application : 05.10.2001

(51)Int.Cl. F02D 13/02
F02D 15/00
F02D 43/00
F02D 45/00
F02P 5/152
F02P 5/153

(21)Application number : 2000-088272

(22)Date of filing : 28.03.2000

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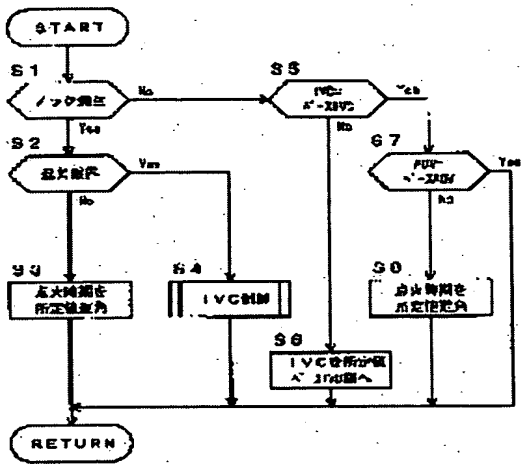
(54) KNOCKING CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To surely avoid generation of knocking without lagging ignition timing any more, when ignition timing reaches a prescribed retard timing limit by generation of knocking.

SOLUTION: The presence or the absence of generation of knocking is detected (S1) and ignition timing is retarded, when knock is generated (S3). When knocking is still generated, even after ignition timing reaches a prescribed retard timing limit, valve timing for an intake valve, more particularly, intake valve closing timing IVC is controlled to decreasing directions of intake air quantity and an effective compression ratio by a variable valve system (S2→S4). More specifically, a control is performed in the direction that the intake valve closing timing IVC is made later than a bottom dead center or in a direction that IVC is made earlier than the bottom dead center.



LEGAL STATUS

[Date of request for examination] 26.09.2003

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the knock control unit which used together ignition timing control and adjustable valve train control (valve timing control) about an internal combustion engine's knock control unit.
[0002]
[Description of the Prior Art] Before, the existence of generating of a knock (knocking) is detected as an internal combustion engine's knock control unit, the lag (retard) of the ignition timing is carried out at the time of knock generating, and what avoided generating of a knock is known well.
[0003] on the other hand, it is shown in JP,8-200025,A etc. as an internal combustion engine's adjustable moving valve mechanism -- as -- for example, electromagnetism -- using a driving gear, an inlet valve and an exhaust valve are driven and there are some which made these switching actions (valve timing) controllable at arbitration.
[0004]
[Problem(s) to be Solved by the Invention] by the way -- although it corresponds by carrying out the lag of the ignition timing to generating of a knock in the conventional internal combustion engine's knock control unit -- that an effective compression ratio becomes larger than a layout value by deposition of the deposit to a combustion chamber **** -- a fuel -- if description uses an extremely bad gasoline or conditions, such as a rise of an intake-air temperature, lap, it is possible that correspondence becomes impossible by the ignition timing lag cost of knock control.
[0005] Moreover, the amount of lags of ignition timing (lag limit) is enlarged, and if it is going to correspond, an exhaust-gas temperature will rise. This invention aims at enabling it to avoid generating of a knock certainly using an adjustable moving valve mechanism, without carrying out the lag of the ignition timing more than it, when ignition timing reaches a predetermined lag limit according to generating of a knock in view of such a conventional trouble.
[0006]
[Means for Solving the Problem] For this reason, it sets to a knock control unit of an internal combustion engine which has a knock detection means to detect generating of a knock, and an ignition timing amendment control means which carries out the lag of the ignition timing at the time of knock generating in invention concerning claim 1 as shown in drawing 1 . That ignition timing reached a predetermined lag limit at the time of knock generating in a lag marginal judging means to judge, and a lag limit of ignition timing with an adjustable moving valve mechanism It is characterized by establishing a valve timing control means which controls valve timing of an inlet valve in an inhalation air content and the reduction direction of an effective compression ratio.
[0007] That is, although existence of generating of a knock is detected and the lag of the ignition timing is carried out at the time of knock generating, even if ignition timing reaches a predetermined lag limit, when a knock occurs in addition, valve timing of an inlet valve is controlled by adjustable moving valve mechanism in an inhalation air content and the reduction direction of an effective compression ratio, and

a knock is avoided with it.
[0008] In invention concerning claim 2, said valve timing control means is characterized by controlling an inlet-valve close stage in the direction made later than a bottom dead point at the time of knock generating in a lag limit of ignition timing.
[0009] In invention concerning claim 3, said valve timing control means is characterized by controlling an inlet-valve close stage in the direction carried out earlier than a bottom dead point at the time of knock generating in a lag limit of ignition timing.
[0010] In invention concerning claim 4, said valve timing control means is characterized by controlling in the direction which carries out an inlet-valve close stage early, and controlling an inlet-valve close stage by field whose inlet-valve close stage of the base is after a bottom dead point in the direction made late in a field whose inlet-valve close stage of the base is near a bottom dead point at the time of knock generating in a lag limit of ignition timing.
[0011] In invention concerning claim 5, said valve timing control means returns valve timing gradually to timing of the base at the time of knock un-generating, and after, as for said ignition timing amendment control means, valve timing is returned to timing of the base, it is characterized by carrying out the tooth lead angle of the ignition timing gradually.
[0012] In invention concerning claim 6, when judged with ignition timing having reached a predetermined lag limit with said lag marginal judging means, it is characterized by establishing a base ignition timing means for switching which switches ignition timing of the base to base ignition timing for regular gasoline from base ignition timing for high-octane gasoline (high octane value) gasolines.
[0013]
[Effect of the Invention] According to invention concerning claim 1, even if ignition timing reaches a predetermined lag limit, in the abnormality situation where a knock occurs in addition and where it cannot respond in the usual knock control, a knock is certainly avoidable by controlling the valve timing of an inlet valve in an inhalation air content and the reduction direction of an effective compression ratio with an adjustable moving valve mechanism.
[0014] Since an effective compression ratio will be made small even if it compares with the case where can control the rise of an exhaust-gas temperature and air is only extracted by the throttle valve as compared with the case where the lag of the ignition timing is carried out further if it is this method, the maximum firing pressure and temperature become low, and a knock can be avoided more certainly.
[0015] According to invention concerning claim 2, at the time of knock generating in the lag limit of ignition timing, an inhalation air content and an effective compression ratio can be decreased, and a knock can be certainly avoided by controlling an inlet-valve close stage in the direction made later than a bottom dead point.
[0016] According to invention concerning claim 3, at the time of knock generating in the lag limit of ignition timing, without producing the blow return by the inhalation-of-air system, an inhalation air content and an effective compression ratio can be decreased, and a knock can be certainly avoided by controlling an inlet-valve close stage in the direction carried out earlier than a bottom dead point.
[0017] According to invention concerning claim 4, at the time of knock generating in the lag limit of ignition timing, without producing the blow return by the inhalation-of-air system again, an inhalation air content and an effective compression ratio can be decreased, and a knock can be certainly avoided by detailed control of timing by controlling an inlet-valve close stage in the direction carried out early in the low rotation field whose inlet-valve close stage of the base is near a bottom dead point. moreover, the crown whose inlet-valve close stage of the base is after a bottom dead point -- in a rotation field, a knock is certainly avoidable by controlling an inlet-valve close stage in the direction made late with detailed control of timing.
[0018] According to invention concerning claim 5, valve timing can be made to shift to the knock control by the usual ignition timing by returning gradually to the timing of the base first as promptly as possible at the time of knock un-generating.
[0019] When it judges [according to invention concerning claim 6] that ignition timing arrived at the predetermined lag limit especially in the case of the engine of high-octane-gasoline specification By

regarding it as what is using regular gasoline, and switching the ignition timing of the base to the base ignition timing for regular gasoline from the base ignition timing for high octane gasolines Without shifting to large valve timing control of the rebound phenomenon of TORUKUHE, when regular gasoline is actually being used, the lag of the ignition timing is carried out proper, and it becomes possible to avoid a knock.

[0020]

[Embodiment of the Invention] The gestalt of operation of this invention is explained below. Drawing 2 is the system chart of the internal combustion engine which shows 1 operation gestalt of this invention.

[0021] an ignition plug 4 is surrounded in the combustion chamber 3 formed by the piston 2 of each gas column of an internal combustion engine (henceforth an engine) 1 -- as -- electromagnetism -- it has drive-type an inlet valve 5 and an exhaust valve 6. 7 is an inhalation-of-air path and 8 is a flueway.

[0022] the electromagnetism of an inlet valve 5 and an exhaust valve 6 -- the basic structure of a driving gear (adjustable moving valve mechanism) is shown in drawing 3 . The plate-like needle 22 is attached in the valve stem 21 of a valve element 20, and this needle 22 is energized by the center valve position with springs 23 and 24. and this needle 22 bottom -- the object for valve opening -- electromagnetism -- a coil 25 arranges -- having -- a top -- the object for clausiliums -- electromagnetism -- the coil 26 is arranged.

[0023] therefore, the time of making it open -- the object for upper clausiliums -- electromagnetism -- the object for valve opening of the bottom after stopping the energization to a coil 26 -- electromagnetism -- the lift of the valve element 20 is carried out, and it is made to open by energizing in a coil 25 and adsorbing a needle 22 with the down side on the contrary, the time of carrying out clausilium -- the object for lower valve opening -- electromagnetism -- the object for the clausiliums of the top after stopping the energization to a coil 25 -- electromagnetism -- by energizing in a coil 26 and adsorbing a needle 22 with the up side, the sheet section is sat and clausilium of the valve element 20 is carried out.

[0024] It returns to drawing 2 and the ** system throttle valve 9 is formed in the inhalation-of-air path 7 at the upstream of an inlet manifold. The electromagnetic fuel injection valve 10 is formed in the inhalation-of-air path 7 for every gas column again at each branch section of an inlet manifold.

[0025] In here actuation of an inlet valve 5, an exhaust valve 6, the ** system throttle valve 9, a fuel injection valve 10, and an ignition plug 4 It is controlled by the control unit 11. To this control unit 11 A crank angle signal is outputted synchronizing with engine rotation. By this with a crank angle location The others [grade / air flow meter 14] which detect the inhalation air content Qa in the throttle-valve 9 upstream of the crank angle sensor 12 which can detect an engine speed Ne, the accelerator pedal sensor 13 which detects the accelerator opening (the amount of accelerator pedal treading in) APO, and the inhalation-of-air path 7, The signal is inputted from the knock sensor 15 as a knock detection means.

[0026] A knock sensor 15 is attached in the main part of the cylinder block of an engine 1 etc., outputs the signal according to engine vibration by the piezoelectric device, and can take out the signal (knock signal) of the specific frequency component relevant to knock vibration from the output signal. In addition, you may make it take out a knock signal from the output signal using the cylinder internal pressure sensor of the piezo-electric mold which is formed in an ignition plug 4 in the shape of [the] a washer, and is attached in it as a knock sensor 15.

[0027] Control of the ignition timing of the ignition plug 4 in a control unit 11 is amended according to the existence of generating of engine operation conditions and the knock based on [specifically with reference to an engine speed Ne and Loads (accelerator opening, a cylinder inhalation air content, or fuel oil consumption) TQ to a map set the base ignition timing ADVbase, and knock control amends this, namely,] the signal from a knock sensor 15, and is performed by computing the final ignition timing ADV.

[0028] Moreover, when ignition timing ADV reaches a lag limit by knock control and a knock still occurs in this invention, the adjustable moving valve mechanism is made to perform knock control by controlling the valve timing of an inlet valve 5 and an exhaust valve 6, especially the inlet-valve close stage IVC.

[0029] This knock control is explained. Drawing 4 is the flow chart of a knock control routine. Step 1 (it is described in drawing as S1.) The existence of generating of a knock is detected based on the signal from a knock sensor 15 at it being the same as that of the following. From the signal according to the engine vibration outputted from a knock sensor 15, it is extracting the signal (knock signal) of the specific frequency component relevant to knock vibration, and the level of knock vibration is detected and, specifically, the existence of generating of a knock is judged by the size. This portion is equivalent to a knock detection means with a knock sensor 15.
[0030] It progresses to step 2 at the time of knock generating (in the case of with a knock). At step 2, it judges whether it is that ignition timing ADV is controlled by the lag of the ignition timing ADV by continuous generating of a knock to the predetermined lag limit (amount RETof lags >= predetermined value). This portion is equivalent to a lag marginal judging means.
[0031] When a lag limit is not arrived at, it progresses to step 3. At step 3, the predetermined value lag of the ignition timing ADV is carried out for knock evasion. Specifically predetermined value deltaRET increase of the amount RET of ignition timing lags is carried out (RET=RET+delta RET), the amount RET of lags is subtracted from the base ignition timing (tooth-lead-angle value) ADVbase set with reference to a map from an engine speed Ne and Load TQ, and ignition timing ADV=ADVbase-RET is computed and controlled. This portion is equivalent to an ignition timing amendment control means.
[0032] When ignition timing ADV reaches a predetermined lag limit by the continuous lag (in the case of an amount RETof lags >= predetermined value), it progresses to step 4 from step 2. The valve timing of an inlet valve 5 and an exhaust valve 6, especially the inlet-valve close stage IVC are controlled by step 4 in an inhalation air content and the reduction direction of an effective compression ratio with an adjustable moving valve mechanism for knock evasion in a lag limit (IVC control). This portion is equivalent to a valve timing control means.
[0033] As specifically shown in drawing 5 (b) to the valve timing at the time of the full load shown in drawing 5 (a) (4 / 4:00), it controls in the direction which controls in the direction which makes the inlet-valve close stage IVC later than a bottom dead point BDC, or (IVC of ******) carries out the inlet-valve close stage IVC earlier than a bottom dead point BDC at the time of knock control (already IVC of closing), and it decreases an inhalation air content and an effective compression ratio. In addition, an exhaust air valve-closing time term and IVO of an exhaust-valve-opens stage and EVC are inlet-valve open stages, and the inside EVO of drawing 5 sets these constant.
[0034] furthermore, in the low rotation field whose inlet-valve close stage (base I VC) of the base is near BDC (or before), in detail at the time of knock generating in the lag limit of ignition timing the crown whose inlet-valve close stage (base I VC) of the base it controls in the direction (already IVC of closing) which carries out the inlet-valve close stage IVC early, and is after BDC -- the inlet-valve close stage IVC is controlled by the rotation field in the direction (IVC of ******) made late.
[0035] if closing is already compared with ****** -- the case of ****** -- an inhalation-of-air system -- blowing -- already from an intake-air temperature rising or producing an inhalation air content measurement error with an air flow meter, although the closing is more advantageous If it is already made closing when the inlet-valve close stage (base I VC) of the base is after BDC, the modification cost of timing must be enlarged (only by bringing forward slightly, although an inhalation air content is reduced). It is because an effective compression ratio goes up, so it is not suitable for detailed control like knock control and we are anxious about the rebound phenomenon to operability.
[0036] When controlling as mentioned above, IVC control at step 4 of drawing 4 is performed according to the IVC control subroutine of drawing 6 . At step 41, base I VC judges whether it is near BDC (or before), in Yes, it progresses to step 42, and it carries out IVC early [predetermined value] (already closing). the case (when base I VC is after BDC) of No -- step 42 -- progressing -- IVC -- a predetermined value -- it is made late (******).
[0037] In the abnormality situation where it cannot respond by the usual knock control that in addition a knock occurs, by control of such an inlet-valve close stage IVC even if ignition timing reaches a predetermined lag limit by controlling an inhalation air content and an effective compression ratio in the reduction direction, a knock can be certainly avoided now.

[0038] At the time of knock un-generating, it progresses to step 5 from step 1 (when you have no knock). At step 5, it judges whether it is IVC= base I VC. Consequently, when IVC is not base I VC, it progresses to step 6 (when knock control by IVC is being performed), and IVC is returned to the predetermined value and base I VC side.
[0039] In the case of IVC= base I VC, it progresses to step 7 (when knock control by IVC is omitted), and it judges whether it is that ignition timing ADV is the base ignition timing ADVbase (ADV= base ADV).
[0040] Consequently, when ADV is not Base ADV, it progresses to step 8 and the predetermined value tooth lead angle of the ignition timing ADV is carried out. Specifically predetermined value deltaRET reduction of the amount RET of ignition timing lags is carried out (RET=RET-delta RET), the amount RET of lags is subtracted from the base ignition timing ADVbase set with reference to a map from an engine speed Ne and Load TQ, and ignition timing ADV=ADVbase-RET is computed and controlled.
[0041] It cannot be overemphasized that ignition timing ADV is maintained at the base ignition timing ADVbase in the case of the ADV= base ADV. In addition, step 7 is skipped, and it may be made to carry out the tooth lead angle of the ignition timing ADV by this flow, at the time of knock un-generating, although he is trying to complete ignition timing ADV at the base ignition timing ADVbase at the time of knock un-generating to a knock limit because it is made to progress to step 8 in the case of IVC= base I VC by judgment at step 5.
[0042] Next, other operation gestalten of this invention are explained. With the engine of high-octane-gasoline specification, the map for high octane gasolines set to the tooth-lead-angle side is used as a map for a base ignition timing ADVbase setup compared with the map for regular gasoline.
[0043] Drawing 7 is the flow chart of the knock control routine in the engine of high-octane-gasoline specification, and steps 21 and 22 are added to the flow of drawing 4 . When ignition timing ADV reaches a predetermined lag limit by the continuous lag (in the case of an amount RETof lags >= predetermined value), it progresses to step 21 from step 2.
[0044] At step 21, when judging whether it is having already switched the map for a base ignition timing ADVbase setup to the map for regular gasoline from the map for high octane gasolines (finishing [map change over]) and having not yet switched, it progresses to step 22 and switches to the map for regular gasoline. This portion is equivalent to a base ignition timing means for switching.
[0045] By this, the current amount RET of lags will be subtracted from base ignition timing ADVbase' in the map for regular gasoline, ignition timing ADV=ADVbase'-RET will be computed and controlled, and a lag can be greatly carried out to the lag limit in regular gasoline by base ignition timing being switched to the base ignition timing for regular gasoline from the base ignition timing for high octane gasolines.
[0046] Thus, without shifting to valve timing control by considering that regular gasoline is used and switching the ignition timing of the base to the base ignition timing for regular gasoline from the base ignition timing for high octane gasolines, when regular gasoline is actually being used when it judges that ignition timing arrived at the predetermined lag limit in the engine of high-octane-gasoline specification, the lag of the ignition timing is carried out proper, and it becomes possible to avoid a knock.
[0047] When finishing [map change over] (i.e., even if it switches a map and carries out knock control, when the knock has occurred in addition), it progresses to step 4 from step 21. The valve timing of an inlet valve 5 and an exhaust valve 6, especially the inlet-valve close stage IVC are controlled by step 4 in an inhalation air content and the reduction direction of an effective compression ratio with an adjustable moving valve mechanism for knock evasion in a lag limit (IVC control). Others are the same.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The functional block diagram showing the configuration of this invention
[Drawing 2] The system chart of the engine in which 1 operation gestalt of this invention is shown
[Drawing 3] the electromagnetism of an induction-exhaust valve -- basic structural drawing of a driving gear
[Drawing 4] The flow chart of a knock control routine
[Drawing 5] Explanatory drawing of valve timing
[Drawing 6] The flow chart of an IVC control subroutine
[Drawing 7] The flow chart of the knock control routine which shows other operation gestalten
[Description of Notations]
1 Engine
4 Ignition Plug
5 Electromagnetism -- Inlet Valve of Drive Type
6 Electromagnetism -- Drive-type Exhaust Valve
9 ** System Throttle Valve
10 Fuel Injection Valve
11 Control Unit
12 Crank Angle Sensor
13 Accelerator Pedal Sensor
14 Air Flow Meter
15 Knock Sensor

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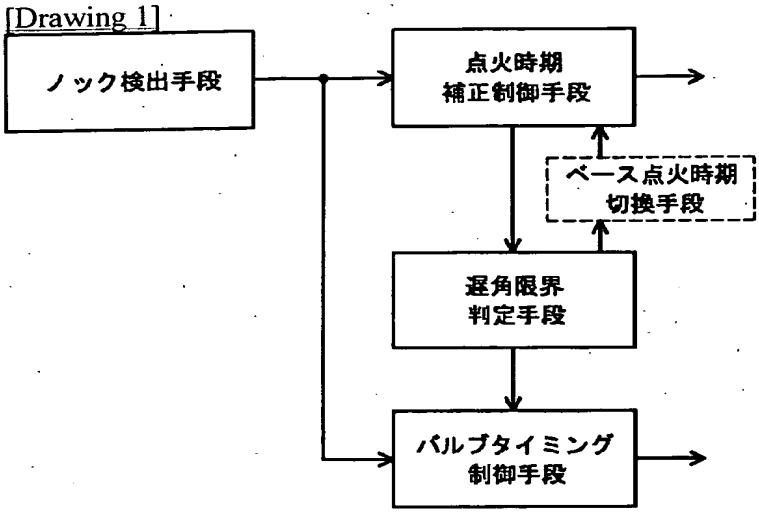
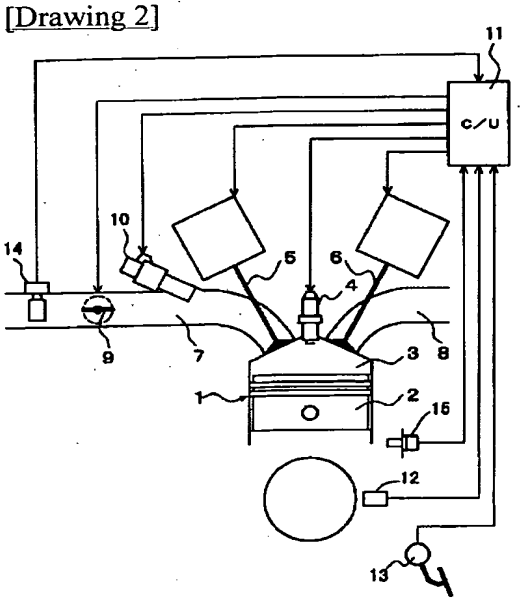
DRAWINGS

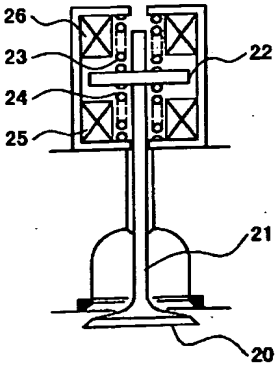
[Drawing 1]



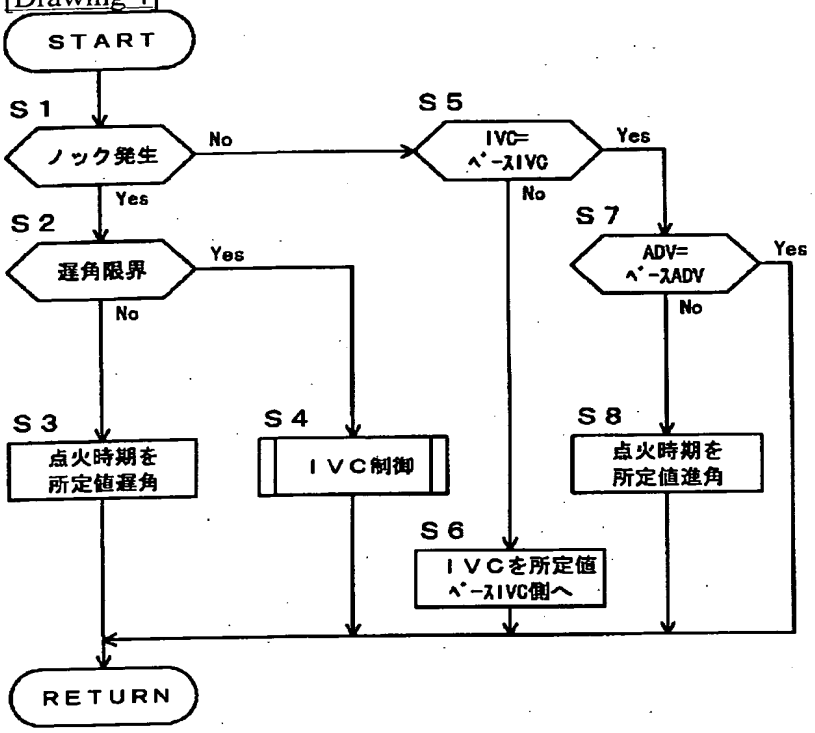
[Drawing 2]



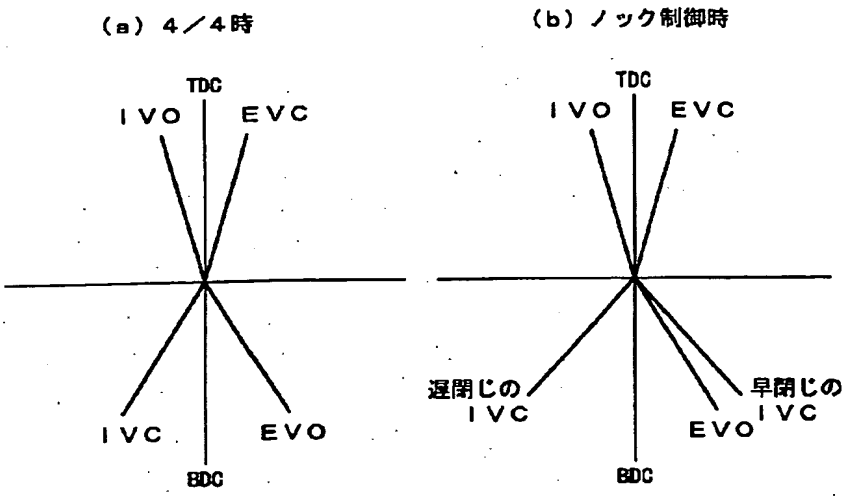
[Drawing 3]



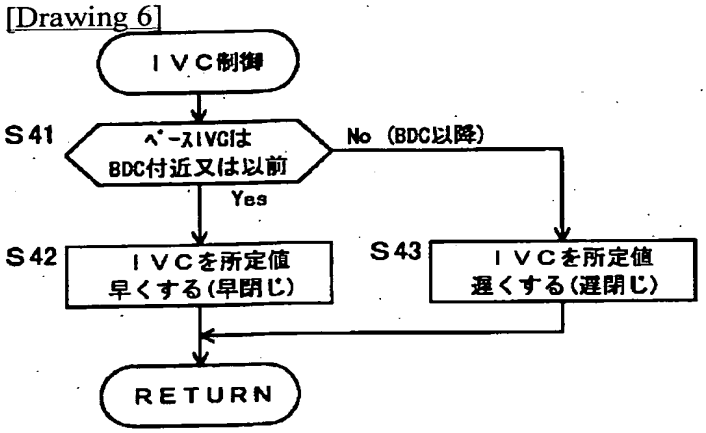
[Drawing 4]



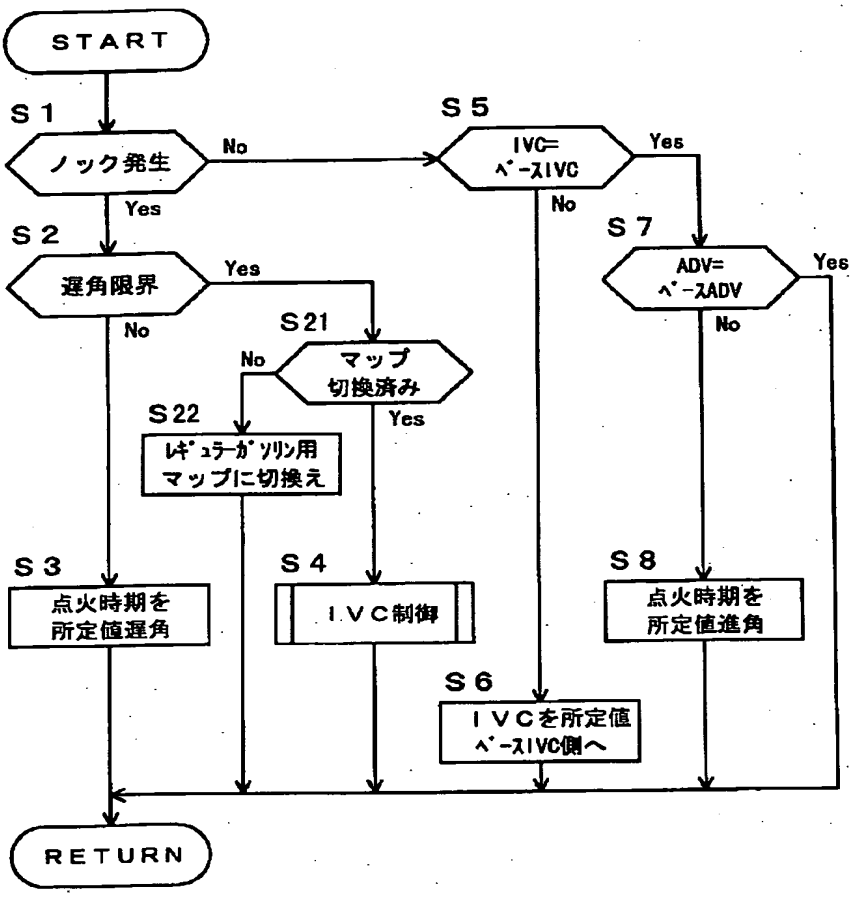
[Drawing 5]



[Drawing 6]



[Drawing 7]



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CLAIMS

[Claim(s)]
[Claim 1] A knock detection means to detect generating of a knock An ignition timing amendment control means which carries out the lag of the ignition timing at the time of knock generating It is the knock control unit of an internal combustion engine having the above, and is characterized by establishing a valve timing control means which controls valve timing of an inlet valve in an inhalation air content and the reduction direction of an effective compression ratio with an adjustable moving valve mechanism at the time of knock generating in a lag marginal judging means to judge that ignition timing reached a predetermined lag limit, and a lag limit of ignition timing.
[Claim 2] Said valve timing control means is the knock control unit of an internal combustion engine according to claim 1 characterized by controlling an inlet-valve close stage in the direction made later than a bottom dead point at the time of knock generating in a lag limit of ignition timing.
[Claim 3] Said valve timing control means is the knock control unit of an internal combustion engine according to claim 1 characterized by controlling an inlet-valve close stage in the direction carried out earlier than a bottom dead point at the time of knock generating in a lag limit of ignition timing.
[Claim 4] Said valve timing control means is the knock control unit of an internal combustion engine according to claim 1 characterized by controlling by field whose inlet-valve close stage of the base is near a bottom dead point in the direction which carries out an inlet-valve close stage early, and controlling an inlet-valve close stage by field whose inlet-valve close stage of the base is after a bottom dead point in the direction made late in it at the time of knock generating in a lag limit of ignition timing.
[Claim 5] It is the knock control unit of an internal combustion engine of any one publication of claim 1 - claim 4 with which said valve timing control means returns valve timing gradually to timing of the base at the time of knock un-generating, and said ignition timing amendment control means is characterized by carrying out the tooth lead angle of the ignition timing gradually after valve timing is returned to timing of the base.
[Claim 6] A knock control unit of an internal combustion engine of any one publication of claim 1 characterized by establishing a base ignition timing means for switching which switches ignition timing of the base to base ignition timing for regular gasoline from base ignition timing for high octane gasolines when judged with ignition timing having reached a predetermined lag limit with said lag marginal judging means - claim 5.

[Translation done.]